and chlorine atoms become respectively combined with water. With sufficient water present the original union between the sodium and chlorine atoms will become entirely severed, the Faraday bundle starting with its positive extremity on the sodium atom will terminate at its negative end *by means of a plurality of strands on a number of water molecules*, and similarly the Faraday bundle emanating by its negative extremity from the chlorine atom will terminate at its positive end in a plurality of strands also on a number of water molecules. In such a solution we should thus have independence of the sodium and chlorine atoms, or the phenomenon of ionisation. In such a solution, moreover, the union between sodium and chlorine would be entirely abolished through the complete diversion of the strands of the Faraday bundle formerly uniting them, whilst the union between the oxygen and hydrogen of the water molecules would be but slightly weakened owing to only a small fraction of the total number of strands in the bundles uniting the oxygen and hydrogen in each molecule being diverted by the sodium and the chlorine. The dissociation into its ions of an electrolyte on solution in water would thus be the consequence of the antecedent hydration of the ions.

Some of the colour changes attending the attachment of water of crystallisation may be interpreted in the same way. Thus anhydrous copper sulphate is colourless, whilst the crystallised salt containing five molecules of water is blue. The direct union of the copper atom by means of two Faraday bundles with the SO_4-group leads to the production of a colourless compound, whilst by the diversion of the strands of these bundles, through the attachment of five molecules of water, the copper atom and the SO_4-group become severed, and the blue colour characteristic of the copper ion makes its appearance.

According to this view solution should always be attended by the weakening of the union between at least one pair of bonds in the molecule of the solute owing to the diversion of at any rate some strands of the bundle or bundles, and such loosening is betrayed in the greater chemical reactivity of substances in solution.

Similarly in catalytic phenomena, the catalytic agent may be regarded as diverting some of the constituent strands of bundles, and the action of water in effecting ionisation, *i.e.* complete diversion of bundles, would thus appear as an extreme case of catalysis, leading to such an acceleration of the velocity of reaction between electrolytes that reactions between ionised electrolytes are practically instantaneous.

It is needless to say that this is merely a preliminary and very imperfect attempt to apply the electronic theory to a few of the most familiar and important chemical phenomena. Sir Oliver Lodge's suggestion with regard to the electrical interpretation of valency and bonds is indeed so luminous and stimulating that it should provoke the careful review of chemical facts by the light of this new conception of the possibility of an indefinite number of different grades of chemical union, of which the union by chemical bond, hitherto the only one generally recognised, is to be regarded merely as an extreme case.

Birmingham, June 27. PERCY F. FRANKLAND.

Science in the Common Examination for Entrance to Public Schools.

IN the interests of education, may I ask you to find room in your columns for the enclosed copy of the science paper recently set in the above examination? The average age of the candidates may be taken as about thirteen years. Comment is almost superfluous. The effect, whether intentional or not on the part of those who set the questions, of such an examination paper must be to discourage science in the preparatory schools. No boy of thirteen years of age could or should be expected to answer more than a very small portion of so advanced a paper. If headmasters of preparatory schools are led to imagine that this is the kind of thing that is expected of their pupils, in very despair they will be forced to abandon science entirely, and fall back upon its alternative in this examination—Latin verse.

This common examination has now been held for the first time, and it is important that an emphatic protest should be raised without delay. If the science paper is allowed to be of this unreasonable character, the subject will receive a set-back that will go far towards undoing all that has been tardily achieved during the last twenty years in regard to scientific teaching in our public schools.

OSWALD H. LATTER.

Charterhouse, Godalming, July 2.

June 29, 1904.—SEVENTH PAPER.
(Alternative with Latin Verse.)

COMMON EXAMINATION FOR ENTRANCE TO PUBLIC SCHOOLS.

SCIENCE.—(*One hour.*)

I.—*Physics.*

(1) A weight hangs by two strings each making an angle of 60° with the vertical. Show that the tension of each string is equal to the weight.

(2) A uniform rod 10 feet long and weighing 5 lb. is pivoted 3 feet from one end. A weight of 50 lb. is hung on the end nearer to the pivot. Find what weight must be hung on the opposite end to balance the rod.

(3) Gravity is often measured by the number 32. Explain this. A body is thrown up with a velocity of 48 f. s. In what time will it lose its velocity? In what time will it return to the hand? How high will it go?

(4) A rectangular vessel on a square base is filled with water. Find the relation between the height of the vessel and a side of the base in order that the fluid pressure on one vertical face may equal that on the base.

II.—*Botany.*

(1) Enumerate the floral whorls from outside inwards. Explain what is meant by cohesion and adhesion among floral organs. Make a careful drawing of the section through a flower in which petals and stamens adhere to the calyx tube. Name a flower in which you have observed this structure.

(2) A potato is often spoken of as a root. Is this correct? Give reasons. Name three other cases in which a similar error is made, explaining the real nature of the organ in question.

(3) Draw sections shown in cutting lengthwise through a bean (or acorn) and a grain of barley (or date stone). What difference would be observed during their early growth? Of what great divisions of plants are these characteristic respectively?

(4) What plants would you expect to find in flower in a damp wood on a clay soil in April? Describe one or more of them.

An Early Mercury Pump.

IT may interest some of your readers to know that as early as 1820 an air pump was described depending on the formation of a Torricellian vacuum, and therefore on the same principle as Geissler's and its successors. The paper is by M. Fafchamps—"Description d'une machine pneumatique à l'aide de laquelle on opère le vide sans le secours de la pompe" (*Annales générales des Sciences physiques*, Bruxelles, vol. vi., 1820, pp. 101–2).

A vertical tube standing in a trough is provided with a stop-cock near its upper end. The tube above the stop-cock has a reservoir at the top, and on each side is a stop-cock, one connected with the vessel to be exhausted and the other to a large funnel. The upper end of the reservoir is also provided with a stop-cock. To work the machine the reservoir is first filled with mercury or some other liquid which is introduced through the funnel, the air being expelled through the stop-cock at the top of the reservoir. When filled with liquid the stop-cock of the reservoir is closed, and communication with the funnel is cut off. The stop-cock on the tube is now opened, when a Torricellian vacuum is produced in the reservoir; on opening the cock connected with the receiver air is withdrawn, and so on.

The author remarks that if mercury is used, the vertical tube must be 758 mm. long; if water, the tube must be more than 10 metres, but the length of the tube may be reduced by diminishing the atmospheric pressure on the

surface of the liquid in the trough below. He also remarks that a machine could be devised which would pump up the liquid and open the stop-cocks at the proper times, and thus make the action continuous.

The paper is illustrated.

July 1. HERBERT MCLEOD.

HATS AND HAIR.

PUBLIC attention has been recently directed to the head-gear of civilised man, which, it is held, is neither necessary nor advantageous. We have here one of the attempts of well-meaning reformers to regulate on rational principles the dress of man, and so to assist him in his work of self-adaptation to his surroundings and needs. The object is laudable, and in all probability the scientific truth is with the reformers, but it may be well to review the question on somewhat broad lines.

The scalp is unique among the areas of the human body where hair is abundant, for there has been a notable development of hair in both sexes in this region beyond what can have existed in any of the Anthropoidea that can be placed in the human family tree. This is the more remarkable because man's pelage is a degenerating and disappearing character, except in a few areas. We must assume that when primitive man was in the making, natural selection led to the growth of thick hairy covering on his head which conduced to success in the struggle of life by protection against excessive heat and cold, against rain, and against minor injuries. As he advanced from his ancestral arboreal home into the open, and the range of his life extended, such natural adverse influences as these would call forth useful adaptive modifications, such as increased thickness and length of hair. At a later stage his developing intelligence would bring the same character under the influence of sexual or physiological selection, and this would strongly supplement the earlier factor of natural selection. Between these two factors a very stable character of the race has been produced.

There is considerable evidence that in spite of the stability of this character, the vigour of the hair on the head of man, especially in the male sex, is declining. The complexity of the conditions of civilised life renders it impossible to prove that this is due to the cessation of natural selection and the inability of sexual selection to arrest decline, but it is highly probable that this is the case. The more immediate question is this—is a decline in the growth of hair part of a general degeneration of man's ancestral pelage, or is it due to some factor introduced by man himself? It is declared by the reformers that the wearing of head-gear is responsible for the increase of premature baldness. Hitherto the discussion of the question has consisted of little more than individual opinions and *ex-parte* statements, and it is doubtful if evidence can prove or disprove the doctrine now being advanced. Experiment is, from the nature of the case, out of the question, because of the length of time required and the general complexity of the problem. It would seem that the nearest approach to a solution must rest on analogies derived from other characters of man himself and from the lower animals. The study of adaptive modifications (the "modifications" of Lloyd-Morgan and the "ontogenic variations" of Osborn) shows that they thrive when exposed to the natural conditions amongst which they arose, so long as these do not become excessive.

The wearing of coverings for the head affects the hair which is covered in three ways—the natural forces of sunlight, free ventilation, and movement from wind are prevented, the arteries which supply the skin of the scalp and nourish the hair-follicles are compressed, and nutrition thereby diminished, and the head-dress affords a culture-ground for micro-organisms, being also itself impregnated with them. The absence for the time being of the germicidal effect of the sun's rays and of movement of air, and the warmth and moisture of the contained air are just those conditions which would be chosen for the culture of these low vegetable organisms. Very much of the premature baldness of men is due to dandriff (*Seborrhoea sicca capillitii*), a disorder of the sebaceous glands characterised by excessive secretion of sebum and its accumulation in crusts with an admixture of epithelial débris, which leads to destruction of the hair-bulbs, and this disease is essentially microbic in origin. From these various points of view it seems to be indicated that the wearing of coverings for the head slowly diminishes the vigour of the hair. If this theoretical side of the matter cannot be demonstrated, but is only extremely probable, the practical outcome of it is no less beset with difficulties. A change of custom, if desirable at all, is less called for in the case of women than of men, for in the former the head-gear is mostly of light texture and covers a very small portion of the vertex, at any rate in modern times, and a much larger surface is left exposed to sunlight and air than in the case of men. In addition to this fact it is to be remembered that the evidence for decline in the growth of hair is much less in women than in men. Those whom the practical matter chiefly concerns are children of both sexes, young adults, and all male adults, and to these the reformers speak from a sound physiological basis. Whether or not their advice will be taken, or ignored as a counsel of perfection, remains to be seen, and the change advocated is certain to be the occasion of extravagant partisanship.

Certain objections to it may be anticipated and removed. First, it will be declared to produce "colds." It is most unfortunate that this name is given to what modern medicine calls "catarrh." The belief that "colds" are produced by exposure to draughts or cold winds is dying hard, and is fortified by the old name so long applied to them, but it is to stultify the great teachings of bacteriology to invoke some casual draught as the cause of disorders of which a nasal catarrh is a type. This danger may be entirely disregarded. It would indeed be for the benefit of the public in more ways than one if they became imbued with the knowledge that pathogenic bacteria of some undetermined species are the efficient cause of all catarrhs. Secondly, it may be feared that inflammatory complaints, such as neuritis or "rheumatism" in the head, would arise from uncovering the head. This is highly improbable considering how large a surface of the head is always uncovered, and that there is no greater protection from hair in the parts uncovered than there is on the vertex. Thirdly, there is undoubtedly some danger, even in temperate climates, from exposure of the head to great sun-heat, and against this danger special precautions are and always would be taken. Fourthly, there is the danger from septic organic matter in towns. This can hardly be reckoned as important, for the area which is necessarily exposed to it is considerable, and proper hygiene of the hair would render it unimportant. Fifthly, injury to the texture of the hair from heat and cold winds is feared, and this again is negligible in view of the fact that the already uncovered parts of the head are better provided with vigorous hair than the covered parts.

Whether the reformers have scientific truth on their side or not, it is possible that the æsthetic aspect of the matter will prove the stronger.